Integrating Rye Seed Production and Red Clover into Corn Systems and Nitrogen Management

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Introduction

This study is designed to investigate nitrogen (N) response in cereal rye seed production, influence of a red clover cover crop on corn N fertilization requirement, and the overall integrated-production system on soil nitrate-N. The study is conducted at two locations. This report includes the two-year (2018-19) cereal rye results.

Materials and Methods

The study started fall 2017 with rye planting following soybean harvest at two Iowa State University Research and Demonstration Farms: the Ag Engineering/Agronomy Farm, Boone, Iowa, and the Northern Research and Demonstration Farm, Kanawha, Iowa. At both Boone and Kanawha "new" cereal rye sites were established following soybean in fall 2018.

Treatments were arranged in a split-split-plot randomized complete block design, with red clover as the whole plot (with and without red clover), cereal rye as the split-plot (two varieties), and N rate as the split-split-plot (0, 25, 50, 75, 100, or 125 lb N/acre surface-applied urea treated with urease inhibitor).

Two cereal rye varieties (ND Dylan and Elbon) were planted at a rate of approximately 1.1 million pure live seed/acre October 19, 2017, and September 24, 2018 (Boone) and October 20, 2017, and October 23, 2018 (Kanawha). The N rates were split-applied, with 25 lb N/acre at rye planting and the remainder in spring at rye green-up. Red clover (Ruby brand, inoculated) was broadcast in mid- to late-March at 15 lb pure live seed/acre. After rye harvest, the non-clover areas were mowed as needed for weed control. The clover was not mowed.

All four sites were soil sampled after soybean harvest (fall 2017 or fall 2018) and phosphorus, potassium, sulfur, or lime were applied as needed before rye planting.

Plant height, number of seed head/acre, and grain yield were determined in the cereal rye crop. Post-rye harvest soil profile nitrate-N to the 2-ft depth was measured at 0, 75, and 125 lb N/acre rates. Canopy sensing, normalized difference vegetative index (NDVI), was used to assess the rye N status and plant biomass. Nitrogen response equations were used to determine the agronomic optimum N rate (AONR) of the cereal rye.

Results and Discussion

Averaged across N rates, rye grain yield of the ND Dylan variety was consistently higher than the Elbon variety (Table 1). Rye grain yields were relatively low for both varieties. The low yields may have resulted from late-fall planting dates and less than ideal spring weather conditions, which caused rye plant stress and compromised yield potential.

Cereal rye grain yield increased with increasing N rate. The across-site AONR was similar for both varieties, 85 lb N/acre for ND Dylan and 89 lb N/acre for Elbon. At the AONR, grain yield was higher for ND Dylan, 49.8 bushels/acre, versus 33.8 bushels/acre for Elbon.

Rye canopy sensing NDVI values reflected increasing N rate and were greater for ND Dylan than Elbon, reflecting greater plant canopy and population. The NDVI reached a maximum value at approximately the same N rate as grain yield for each variety. The ND Dylan variety was slightly taller than Elbon and also had a greater seed head count. Both varieties increased in plant height and number of heads with N application.

Soil nitrate-N (data not shown) in the top two feet of soil after rye harvest was low overall, increased only slightly with N application (17, 18, and 21 lb nitrate-N/acre for the zero, 75, and 125 lb N/acre rates), and was not impacted by inter-seeded red clover.

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Table 1. Rye seed production and plant measurements for each rye variety, 2018-2019. Rye plant height and seed head count after full plant height, and rye crop canopy sensing at Feekes' growth stage 9/10 (full flag leaf emergence/boot). Preliminary data and analysis.

	ND Dylan				Elbon			
Fertilizer N rate	Grain yield	Plant height	Seed heads	Canopy sensing	Grain yield	Plant height	Seed heads	Canopy sensing
lb/ac†	bu/ac	in.	No./ac x 1,000	NDVI§	bu/ac	in.	No./ac x 1,000	NDVI§
0	34.7	52	1160	0.585	23.9	50	950	0.487
25	38.6	54	1270	0.633	26.6	52	1020	0.520
50	43.5	55	1290	0.700	29.3	53	1150	0.574
75	48.1	56	1470	0.741	32.3	54	1150	0.614
100	49.0	57	1500	0.758	33.8	55	1260	0.634
125	50.5	56	1540	0.774	33.8	54	1300	0.620
Pr>F‡	<0.001	<0.001	0.010	<0.001	<0.001	0.013	0.006	<0.001
AONR§ (lb N/ac)	85	62	109	85	89	74	115	83
Measurement§	49.8	56	1540	0.766	33.8	54	1300	0.627

†Total N applied, 25 lb N/acre applied at rye planting, remainder top-dressed at rye green-up in spring.
‡Significance of mean N rate response.
§AONR, agronomic optimum N rate for yield, or maximum N response rate and measurement. NDVI, normalized difference vegetative index.